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(19)

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(54) ELECTRICALLY CONDUCTIVE ADHESIVE TAPE

(71) We, EVODE LIMITED, a British Company, of Common Road, Stafford, Staffordshire, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of adhesively bonding two surfaces together and to electrically conductive adhesive tapes for use in such a method.

Hot melt adhesives are useful in a wide number of applications because they are capable of forming a strong bond rapidly between a variety of different surfaces and do not require on site premixing of reactive ingredients. There are however situations where hot melt adhesives would otherwise be especially suitable for forming adhesive bonds, but where the particular conditions in which the bond must be made make it difficult to utilise hot melt adhesives. Examples of such situations include bonding large areas of long overlap joins particularly where the surfaces to be joined are good conductors of heat. Under such conditions the short open time of hot melt adhesives makes it difficult to place the preheated adhesive before the necessary surface tack has disappeared. Hot melt adhesives may also be precluded where site conditions make it impractical or too expensive when using existing methods for heating and placing hot melt adhesives.

The present invention makes it possible to utilize hot melt adhesives in many of the situations where hot melt adhesives could not previously be used for one or more of the above reasons as well as in more favourable circumstances.

According to the present invention there is provided a method of adhesively bonding two surfaces together which comprises positioning between said surfaces an adhesive tape (as herein defined) comprising a sheet-like metal foil substrate having perforations therein and a continuous or discontinuous layer of a hot melt adhesive supported on only one surface of the substrate which adhesive extends into the perforations in the foil, and electrically heating the tape whereby the molten adhesive flows through the perforations and, on cooling, forms an adhesive bond between said surfaces.

The invention also includes an adhesive tape (as herein defined) which comprises a sheet-like metal foil substrate having perforations therein and on only one surface of the substrate a continuous or discontinuous coating of a hot melt adhesive which extends into the perforations in the foil, the perforations in the substrate being sufficiently large to permit passage of the adhesive when the adhesive is heated to its operational temperature.

For the purposes of this Specification the term "adhesive tape" is used to include adhesive articles of sheet like form generally and is not limited to articles of particular dimensions.

The size of the holes depends to some extent upon the viscosity of the adhesive when heated to its operational temperature but the holes should preferably be large enough to permit easy flow of the adhesive through the substrate when heated to the operational temperature. Good results have been obtained using triangular shaped holes of approximately 3/8 in. side, although this is intended to be only a general guide and other shapes and sizes of holes may be used to achieve the general objective indicated above.

The holes may be a regular or irregular distribution and we have found that it is satisfactory to use conductive metal foil strips in which the total area of the openings

is from 2% to 30% of the total surface area of the conductive foil.

The holes are conveniently formed in the metal foil prior to coating with adhesive by perforating with a suitably sized and shaped punching tool. Metal displaced in this operation may be deposited on the underside of the foil towards one or more sides of the apertures and may be flattened by pressing or rolling or alternatively left undisturbed. In some cases it may be advantageous to leave the cut portions of the foil projecting from the reverse side since this can give the tape valuable gap filling properties.

Any metal foil may be used as a substrate for the adhesive tape but aluminium is preferred because of its general availability and relatively low cost. Aluminium foil having a thickness of between .0005 and .01 ins. has been found very satisfactory.

As indicated above it is preferred to form the perforations in the substrate before coating with adhesive. One reason for this is that it is advantageous in the coating operation to cause some of the adhesive to flow through the perforations in the tape.

Any convenient method may be used for applying the continuous or discontinuous coating of hot melt adhesive to one surface of the substrate. Suitable methods include roller coating or spreading with a doctor blade or lamination to a preformed film of adhesive. It is also possible to extrude the adhesive on to one side of the substrate either as a continuous bead or as a series of blobs of adhesive. Where the adhesive forms a discontinuous coating the adhesive deposited on the substrate should coincide with the holes in the foil. By controlling the coating weight, which may be, e.g. from .1 ozs. per sq. yd. to 50 ozs. per sq. yd. (preferably from 15 to 30 ozs. sq. yard) and the coating conditions e.g. temperature, viscosity and coating speed, the adhesive may be induced to flow into and through the holes to a greater or lesser degree according to the particular requirements. It is also possible to coat the adhesive onto the substrate in a first step either as a melt or from a solution or emulsion and in a subsequent heating step using hot air, heated rollers, a heated press or an infra red tunnel, cause the coating of adhesive to flow to some extent through the holes in the substrate. The equipment in the second step may be part of the equipment for the coating step or may be a separate unit. According to the properties of the adhesive coating and the temperature of the adhesive coming from the coating equipment, it may be necessary to wind up the tape or stack the sheet using an interleaving sheet material having release properties to prevent blocking.

A variety of hot melt adhesive compositions may be used for coating the substrate and may be based on natural or synthetic rubbers, for example, natural crepe or smoked sheet, butyl or styrene butadiene rubbers. Polyvinyl chloride, polyvinyl acetate, polyethylene, chlorinated polyethylene, ethylene vinyl acetate are examples of other thermoplastic synthetic polymers which may form the basis of the hot melt composition.

Natural or synthetic resins, such as wood rosin and rosin derivatives, e.g. those derived from tall oil and natural gum may also be incorporated in the hot melt adhesives in accordance with normal compounding procedure. Esters derived from these resins or from hydrogenated polymerised forms may also be used as well as rosins derived from by products of petroleum and coal tar manufacture.

The hot melt adhesive formulations may also include natural or synthetic waxes including amorphous and partially crystalline waxes. Plasticisers such as dicyclohexyl phthalate, camphor substituted sulphonamides may also be incorporated in the composition according to normal practice. The adhesive composition used for coating the substrates preferably include mineral or synthetic fillers which may be particular or fibrous in nature. The compositions may also include anti-oxidants.

Examples of typical hot melt adhesive formulations are as follows:

Example 1

	weight per cent
1) Natural Rubber	19.8
2) Wood Rosin	30
3) Calcium Carbonate	45
4) Dicyclohexyl phthalate	5
5) Anti-oxidant	0.2

Components (1) and (2) were heated together in a mixer and when a homogeneous mixture had been obtained the remaining components were mixed in. The resultant mixture was coated as a holt melt onto a perforated aluminium foil using a doctor blade.

Example 2

	weight per cent
1) Ethylene vinyl acetate copolymer	20 to 50
2) Esterified rosin	10 to 35
3) Barium sulphate	10 to 55

Components (1) and (2) were mixed together in a heated mixer and the barium sulphate filler was then mixed in. A perforated metal foil was coated with the resultant mixture in the form of a hot melt using a doctor blade.

The adhesive tapes prepared in accordance with the present invention may be used for bonding surfaces together after the tape has been positioned between the surfaces to be joined. Activation of the adhesive is achieved electrically, for example by utilising the heating effect generated by passage of an electric current through the substrate. The electrical current may be provided by mains electric power through a suitable transformer or from a battery. As an alternative to electrical resistance heating, electrical induction heating may be used. A suitable electrical power source is described in our British Patent No. 1,328,346. Provided that the surfaces which are joined are suitable (i.e. resistant to heat and not too thick) the adhesive may be activated by pressing between heated platens.

When using a transformer of the kind described in our above British Patent, it has been found that there is a voltage drop of .63 volts per foot length of tape and an energy dissipation of 126 watts per foot length of tape when using as the substrate of the tape, an aluminium foil, .04 ins. thick and 2 ins. wide with 10% of metal removed by perforation. The transformer tapping most suitable for the length of tape can thus be chosen.

Electrical heating is maintained until the adhesive reaches the prescribed operation temperature at which point the power is switched off and pressure applied to press the surfaces to be joined in intimate contact with the respective sides of the tape. Maximum bond strength would normally be obtained in a few minutes although in cases where the surfaces to be joined have extremely low thermal conductivity it may be necessary to maintain the pressure on the joint for longer.

It will be appreciated that in accordance with the present invention it is unnecessary to coat both sides of the tape with adhesive. This results in two advantages. Firstly, it avoids the rather difficult process of uniformly coating both sides of the tape with adhesive, and secondly in use it is possible to make a satisfactory electrical connection to the tape without having to remove the adhesive coating since one side of the substrate will always be substantially free from adhesive. The tape would normally be folded at its ends to present two bright metal surfaces to the connectors for connecting the tape to the source of electrical power.

WHAT WE CLAIM IS:—

1. A method of adhesively bonding two surfaces together which comprises positioning between said surfaces an adhesive tape (as hereinbefore defined) comprising a sheet-like metal foil substrate having perforations therein and a continuous or discontinuous layer of a hot melt adhesive supported on only one surface of the substrate which adhesive extends into the perforations in the foil and electrically heating the tape whereby the molten adhesive flows through the perforations and, on cooling forms an adhesive bond between said surfaces.

2. A method according to claim 1 wherein the tape is heated by passing an electrical current through the substrate.

3. An adhesive tape (as hereinbefore defined) which comprises a sheet-like metal foil substrate having perforations therein and on only one surface of the substrate, a continuous or discontinuous coating of a hot melt adhesive which extends into the perforations in the foil, the perforations in the substrate being sufficiently large to permit passage of the adhesive when the adhesive is heated to its operational temperature.

4. A tape according to claim 3 in which the total area of the perforations is from 2 to 30% of the total surface area of the substrate.

5. A tape according to claim 3 or claim 4 in which adhesive extends through the perforations to the other side of the foil.

6. A tape according to any one of claims 3 to 5 in which the adhesive coating weight is up to 50 ozs. per square yard.

7. A tape according to any one of claims 3 to 6 in which the substrate is a metal foil between 0.0005 and 0.01 inch thick.

8. A tape according to any one of claims 3 to 7 in which the adhesive coating contains a filler.

9. A tape according to any one of the preceding claims in which the adhesive is based on a natural or synthetic rubber or a thermoplastic synthetic polymer.

10. A tape according to claim 9 in which the thermoplastic polymer is polyvinyl chloride, polyvinyl acetate, polyethylene, chlorinated polyethylene or ethylene vinyl acetate.

11. A tape according to claim 9 or claim 10 in which the adhesive includes a plasticiser.

12. A process for producing an adhesive tape as claimed in any one of claims 3 to 11, which comprises coating a perforated

metal foil with a molten hot-melt adhesive under coating conditions such that the adhesive is induced to flow into the perforations in the foil.

13. An adhesive tape substantially as described with reference to the Examples.

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